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HOW HUNTER-GATHERERS HAVE LEARNED TO HUNT: TRANSMISSION OF HUNTING METHODS AND TECHNIQUES AMONG THE CENTRAL KALAHARI SAN

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ABSTRACT In order to theorize about how hunting methods evolved around the time Neanderthals was being replaced by anatomically modern Homo sapiens (AMH), the hunting methods used by the San people-hunter-gatherers in the modern age—were studied in detail. As a result, it became clear that the San use a wide variety of methods to hunt small mammals and birds, in addition to using bows and spears to hunt large animals. It was also discovered that hunters included not only adult men, but also boys and adult women; boys in particular begin learning skills related to hunting and "reading nature" at the age of four or five. Taking an interest in animals and reading their minds through careful observation—an ability unique to modern humans who are the only animals to possess this faculty—can be traced all the way back to the origins of the Homo sapiens. The human–animal relationship is deeply connected to human evolution, in the sense that it prompted a change in humans' cognitive abilities.

Key Words: Hunting; Traps; Boys and Women; Reading nature.

1. INTRODUCTION

Hunting has played an important part in human evolution. The type of hunting method used depended on: the type of animals being hunted (mammals, birds, reptiles, or fish, and whether they were small, medium, or large); the hunting tool being used (spear, bow and arrow, club, or trap); who the hunters were (men, women, or children), and how they hunted (alone or in groups). Changes in these hunting methods have played a very important role in human evolution.

It is believed that although two species of humans—paleoanthropic man (Neanderthals) and anatomically modern Homo sapiens (AMH)—had lived in either the same or different areas of Europe for tens of thousands of years during the Paleolithic. The former died out approximately 30,000 years ago, and only the latter survived. The fact that Neanderthals was replaced by AMH highlights the differences in hunting methods used by the two species.

Archaeological analyses of faunal remains have suggested that in the Middle Paleolithic, paleoanthropic man hunted primarily large herbivores and had limited cultural diversity. On the other hand, after the Upper Paleolithic, AMH utilized a variety of food resources and hunted a wide variety of small animals, in addition to large herbivores (Kuhn & Stiner, 2006; Richards & Trinkaus, 2009).

Furthermore, Fa et al. (2013) claim that one of the reasons the Neanderthals

died out is that they were unable to change from hunting large animals to hunting small animals, such as hares, since they used clubs and spears with handles for hunting, tools that were not suitable for catching hares. In contrast, early AMH used throwing implements, such as the javelin and bow and arrow, which were ideal for hunting small, fast-moving animals.

Fa et al. (2013) also speculated that among early AMH, the women and children might have stayed at the camp and hunted small animals, while the men went on hunting trips in search of large mammals. Furthermore, Fa et al. note the possibility that early AMH also used dogs for hunting. Based on the bones of dogs excavated from various sites, present-day archeology has dated the domestication of dog back by 12,000 years; however, genetically, the dog became separate from the wolf 30,000 years ago, during the same period in which AMH began to hunt small animals in Europe. Moreover, an isotope analysis of fossilized human bones indicates that whereas the major food source of Neanderthals in Europe, regardless of region or era, was large herbivores, early AMH relied on a variety of food sources, including seafood (Richards & Trinkaus, 2009).

It is evident from both his hunting tools and food sources that AMH had a variety of food choices, as well as a well-developed ability to understand the natural environment that contained those food sources. To extend the range of animals hunted, from large mammals to small and medium animals, birds, and fish, it was necessary for AMH to learn about different vegetation, terrain, celestial bodies, and climates, in addition to acquiring knowledge of the nature and behavior of animals, such as their footprints, feeding habits, and sounds. Thus, we can imagine that a detailed understanding of nature was acquired by "reading" the environment, and further that the development of this skill advanced dramatically among AMH.

In order to theorize about how hunting methods evolved around the time Neanderthals was being replaced by AMH, the hunting methods used by the San people—hunter–gatherers in the modern age—were studied in detail. Whereas the San people is famous for the big-game hunting by bow-and-arrow in the traditional time, they have hunted middle or small sized mammals, birds and reptiles. Previous studies showed that San hunters included not only adult men, but also boys (Tanaka, 1980; Akiyama, 2004) and adult women (Imamura, 1997).

In this study, we also examined the learning process of hunting methods and techniques of the local San to gain an overall understanding of their perspective on nature, with the aim of explaining how these hunter–gatherers in the Kalahari acquired their skills for "reading nature".

2. METHODOLOGY

A field survey was conducted among the hunter–gatherers of the Central Kalahari San (consisting of two language groups, G|ui and G||ana), in New Xade in the Ghanzi District of the Republic of Botswana, between August 11 and September 3, 2013. We studied their hunting techniques by interviewing them about the hunting methods they had used in the past, when they had led more tradi-

tional lives, and by undertaking intensive observations of their current hunting methods.

When speaking of the San people, there is a tendency to focus on how they hunt large mammals such as giraffe, eland, and gemsbok using the bow-and-arrow, and the spear. However, meat is consistently obtained with the routine use of traps (Tanaka, 1980). Tanaka (1980) showed the estimated numbers and weight of animals killed and eaten by a hypothetical average camp of fifty people in a year. I divided the animals of the Tanaka's list into two categories: Large game weighting from 100 to 1,000 kg includes giraffe, Cape eland, greater kudu, gemsbok, Red hartebeest, and Blue wildebeest; and smaller game under 50 kg (mostly in the 1-to-20 kg range) that is includes springbok, bush duiker, steenbok, warthog, leopard, cheetah, black-backed jackal, bat-eared fox, Cape fox, common genet, crested porcupine, springhare, Cape hare, ostrich, kori bustard, guinea fowl, black korhaan, and rock python. The animals belong to category of large game were hunted by the bow and arrow, or the spear. The total weight of large game was 4,650 kg (82.9%), whereas that of the latter game has totaled 956 kg (17.1%) and was caught by traps. The amount of meat obtained by traps cannot be disregarded.

In this study, therefore, we focused on collecting material about trapping, which is a particularly varied practice. We also conducted interviews with boys, adult women, and men who hunted, and made observations while they were hunting. In addition, we consulted the documentation and material that Imamura & Akiyama have been collecting in the local area around Xade and New Xade since 1988 and 1996, respectively, regarding child development and play, as well as the hunting methods used by boys and adult men and women.

3. HUNTING METHODS OF THE CENTRAL KALAHARI SAN

The San's hunting methods are summarized in Tables 1 and 2, which we modified Sugawara's (2000) list by adding hunting methods to of mammals and birds. Sugawara (2000, 2001) interviewed 43 men and 53 women about the mammals that live in Kalahari Desert and can be eaten: Sugawara reported on 34 species of mammals and bats (scientific name was not identified), rodents (scientic name was not identified), and while everyone said they did not eat African skunks, lycaons, rodents, or bats, there was at least one individual who said they had eaten at least one of every other animal—for example, even lions and leopards. No one eats skunk, because of the intense odor, while rodents and bats are not regarded as food because of the small amount of meat they provide (the reason for not eating lycaons is unknown). However, boys will hunt very small animals and birds as much as possible, and eat the meat.

3-1. Large Mammals

In the past, the primary method for hunting large mammals was with a bow-and-arrow; however, it has been replaced by spear hunting today.

Table 1. Animals hunted by G|ui and G|ana*

Order	Common name (Scientific name)	Hunting technique**		
		Man	Woman	Boy
Artiodactyla	Giraffe (*Giraffa camelopardalis*)	A,B,C,D(j***)		
	Cape eland (*Taurotragus oryx*)	A,B,C,D(j)	D(j)	
	Gemsbok (*Oryx gazzella*)	A,B,C,D(j),H	D(j)	
	Greater kudu (*Tragelaphus strepsiceros*)	A,B,C, D(j)	D(j)	
	Red hartebeest (*Alcelaphus caama*)	A,B,C,D(j),H,I		
	Blue wildebeest (*Connnochaetes taurinus*)	A,B,C, D(j),H		
	Springbok (*Antidorcas marsupialis*)	A,D,I	D(j)	
	Bush duiker (*Sylvicapra grimmia*)	A,D,H	D	
	Steenbok (*Raphicerus campestris*)	A,D,H	D	
	Warthog (*Phacochoerus aethiopicus*)	D,E		
	Cape hare (*Lepus capensis*)	D	D	
	Springhare (*Pedetes capensis*)	D,F,G,H	D,G	
	Crested porcupine (*Hystrix africaeaustralis*)	D,E,K		
Rodentia	Ground squirrel (*Xerus inauris*)			K
	Mouses			K
Carnivora	Lion (*Panthera leo*)	J		
	Leopard (*Panthera pardus*)	D(j),J		
	Cheetah (*Acinonyx jubatus*)	D		
	Lycaon (*Lycaon pictus*)			
	Brown hyena (*Hyena brunnea*)	D		
	Spotted hyena (*Crocuta crocuta*)	D		
	Aadwolf (*Proteles cristatus*)	D,E	D	
	Black-backed jackal (*Canis mesomelas*)	D	D	
	Ratel (*Mellivora capensis*)	D	D	
	Common genet (*Genetta genetta*)	D	D	
	Cape fox (*Vulpes chama*)	D	D	
	Bat-eared fox (*Otocyon megalotis*)	D	D	
	Slender mongoose (*Galerella sanguinea*)	D,E,K	D	K
	Yellow mongoose (*Cynictis penicillata*)	D,E,K	D	K
	African wild cat (*Felis libyca*)	D,K	D	
	Caracal (*Felis caracal*)	D		
Tubulidentata	Aardbark (*Orycteropus afer*)	D,E		
Pholidota	Cape pangolin (*Phataginus temmincki*)	E		

* Modified Sugawara's (2000) list.
** See the text.
*** Only for juvenile.

3-1-A. *Bow-and-Arrow Hunting*

This method was often used when hunting alone. The hunter would stalk the game to within about 20 meters, which is the distance an arrow can fly, and shoot a poison arrow; however, the arrow had no fletching and often missed the target. Animal bones and horns (such as giraffe shoulder blades, gemsbok horns, and ostrich foot bones) were used as arrowheads until around 1930, when, by trading with the Bantu people, metal (iron) was gradually introduced, and they began using iron arrowheads with nocks around 1960 (Osaki, 2001).

The poison used was a neurotoxin found in the body fluids of beetle larvae (*Diamphidia simplex*). However, as it could take up to 20 hours for the poison to take effect, the hunter memorized details such as the direction in which their prey had fled, the characteristics of its footprints, and then returned to the camp. Until the hunters could confirm the death of their prey, they could not consume anything other than water, because the San people believed that wounded game would regain energy and flee if the hunter ate any food (Tanaka, 1980). The following morning, several men from the same camp would form a tracking team to go after the prey; if it were still breathing when found, the hunters would kill it by stabbing it through the heart with a spear.

This hunting method had been completely abandoned by the end of 1980s (Osaki, 1984), probably because: 1) It is quite difficult to stalk game to within 20 meters without being noticed; and 2) people could get hurt, and the situation become serious when there the poison was handled improperly.

Having reviewed traditional bow-and-arrow hunt practices, we now consider the hunting methods used by the San today, namely spear hunting, which includes spear hunting with dogs and a horse. Since iron, which is used for the spearheads, is valuable, it was not until the 1950s that the Central Kalahari San began using spears (Osaki, 2001). A spear can only be thrown a short distance (5 meters or less), making it impossible to kill game with a spear alone, and making either a dog or horse essential to the hunt.

Since a horse allows game to be hunted without requiring any extensive knowledge of nature by the hunter, some youths are actively hunting this way today. Here, "knowledge of nature" refers to knowledge of plants and watering holes, which is necessary for procuring food and water while in the bush. When hunting with a horse, this knowledge is not always necessary, because a safari is organized with several donkeys carrying food and water.

3-1-B. *Spear Hunting with a Dog*

While the dog is blocking the game from fleeing, the hunter runs up close to it and stabs it with a spear. When hunting alone, the hunter takes one or two dogs; this number increases to seven or eight dogs when three or four men go hunting together. It appears that the dogs are not specially trained, but that the smart ones learn how to hunt down prey after several hunting trips (Ikeya, 1989). The probability of getting a good hunting dog would increase when you own many dogs. In reality, however, feeding a dog is a burden, and thus there are not many San individuals who own more than one dog.

3-1-C. *Equestrian Hunting (Spear Hunting on Horse Back)*

This hunting method was introduced by the Kalahari (Bants Agro-pastoral people) around 1965 and become popular after 1980s (Osaki, 1984). The hunter approaches the game on horseback, and throws a spear. Alternatively, a hunter who is on foot will run up to the game and kill it with a spear, after another hunter on a horse has it cornered. When there are multiple horses, hunters may launch a pincer attack.

Using a horse is the most efficient hunting method. However, in terms of securing food and water, it is not easy to keep a horse in their settlement.

3-2. Smaller Games

Apart from spears, another hunting tool frequently used by the San is a club. Clubs are most commonly used for killing prey and enemies (snakes and carnivores) that are encountered unexpectedly while walking in the bush, as well as for killing trapped game, as described later.

Instead of a club, some men use a similar but slightly heavier digging stick. As a digging stick is an essential tool for digging out both a hole to set up traps and animal burrows, as well as for gathering rhizome, some individuals have a club and a digging stick, while others only have a digging stick, and use it for beating animals. In addition, women also carry a digging stick whenever they go into the bush, sometimes using it to beat an animal and catch it as game. Consequently, the following hunting methods are used by both men and women.

3-2-D. *Hunting with a Club or a Digging Stick*

When encountering an animal in the bush, the hunter beats it to death with a club or digging stick. This method is often used to hunt not only mature animals but also calves. Dogs sometimes accompany the hunters, because the odds of success increase: Even a woman can easily beat and capture an antelope calf with a digging stick, if accompanied by a dog.

3-2-E. *Hunting Animals in the Burrow*

A spear is thrust into the burrow to stab and kill a nocturnal animal that is resting during the day. This hunting method is used for springhare, aardwolf, crested porcupine, and aardvark, although springhare hunting is also done using a special rod, as described below. Warthogs, which are not nocturnal but do have a habit of escaping into the burrows of other animals—such as those of the porcupine—when encountering an enemy, are also killed with a spear or club.

3-2-F. *Springhare Hunting Using a Pike Pole*

A springhare is hooked with a pike pole about four meters in length. Springhare forage at night and rest in burrows during the day, so once the pole is secured at the entrance of the hole to prevent the springhare from escaping, hunters begin digging in the ground either above the prey or at the entrance of the hole, to capture it.

3-2-G. *Springhare Hunting Using a Flashlight*

When active at night, hunters blind springhares with a flashlight, so they stop moving, and can be beaten. Men and women can be seen using this springhare hunting method.

3-2-H. *Trapping (Rope Trap)*

As this type of trapping is called *!gui* in the San language, meaning "rope" made of the fibers of *Sansevieria aethiopica*, we will call it the "rope trap." This is the method most commonly used by adult men of the Central Kalahari San, for catching smaller-sized antelopes, such as bush duiker and steenbok, in the main, but large animals, such as Cape eland and gemsbok are sometimes caught in this type of trap as well. This hunting method involves setting up a trap by first carefully reading animal footprints, and then predicting the path the game will take; no bait is used. If more than one animal species uses the same path (the so-called "animal trail"), then several kinds of animals can be caught in the same trap.

The wooden structure of the trap is made by joining so-called "male pieces" and "female pieces"; represented by a pin fastened to the rope, and a receiver of the pin fixed in the sand, respectively. The trap is then placed over a hole that has been dug, with a device secured to the end of a looped rope. The rope is twisted around a flexible branch of the *Boscia albitrunca*, and the trap is then covered and hidden with more branches, grass, and sand (especially moist clumps of sand), so that when an animal unknowingly steps on the trap, the device is released, the branch snaps, and the rope is tightened. A hunter will check his "snap trap" once every three to four days and, when an animal caught in a trap is found suspended by one foot from the rope, it is killed with a club.

The rope trap has an extensive enclosure on both sides to prevent animals from walking on paths other than the one with the trap, and it can be used continuously for several months to several years. Thus, unlike spear hunting with a dog or a horse, once this type of trap is set, a hunter can expect a more consistent, though small, return of game per hunt. Furthermore, in addition to eating the meat, the hide of bush duiker and steenbok can be used for making clothes, bedding, wrapping cloths, and rugs. These leather products, which were basic necessities in the past, now also function as trade goods and dowries. Today, trapping is extremely important because it provides materials for folk art, which is a source of cash income.

3-2-I. *Trapping (Tying the Neck of a Large Animal)*

Hunters also set this trap up on a path, but it is designed to snare red hartebeest, at neck height. It is a simple trap with a looped wire secured to trees at both ends; however, its lack of complexity means that predicting the animals' behavior based on their footprints, the availability of trees that provide their food, and climate (e.g., wind strength) becomes much more important.

3-2-J. *Trapping (Bear Trap)*

A large trap made of iron is sometimes used for killing vermin, such as lions

and leopards.

3-3. Small Animals or Birds

The following hunting methods are often used by boys and women, to catch birds and small animals such as mongoose and squirrels.

Table 2. Birds Hunted by G|ui and G||ana*

Family	Common name (Scientific name)	Hunting technique**		
		Man	Woman	Boy
Charadriidae	Crowned plover (*Vanellus coronatus*)	K	K	K
Phasianidae	Guinrea fowl (*Numida meleagris*)	D,K	D	K
Otididae	Redcrested korhaan (*Eupodotis ruficrista*)	K	K	K
	Black korhaan (*Eupodotis afra*)	K	K	K
	Kori bustard (*Ardeotis kori*)	K		
Struthionidae	Ostrich (*Struthio camelus*)	K		
Strigidae	Whitefaced owl (*Otus leucotis*)	D		
Ploceidae	Greyheaded sparrow(*Passer griseus*)			L,M,N
	Great sparrow (*Passer motitensis*)			L,M,N
	Scalyfeathered finch (*Sporopipes squamifrons*)			L,M,N
Fringillidae	Yellow canary (*Serinus flaviventris*)			L,M,N

* Modified Sugawara's (2000) list.
** See the text.

3-3-K. *Trapping (Scragging Trap)*

As this trap is called *!aeqx'ai*, meaning "scragging" in the San language, I will call it the "Scragging trap". A rope is laid around the pillars that are positioned in a circle, and the bait is placed in the center. When the animal eats the bait the device releases, and the rope around the animal's neck tightens. Even today, boys enthusiastically set up this trap to catch dwarf mongoose, using the meat of lizard as bait; women used to set up a palm-shaped trap to catch redcrested korhaan, black korhaan and crowned plover, using the sap of acacia as bait (Figs. 1 & 2).

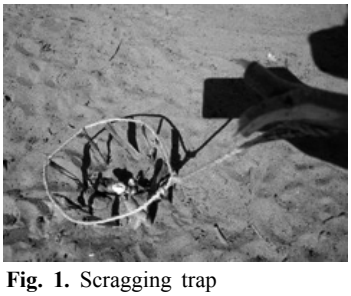

Fig. 1. Scragging trap

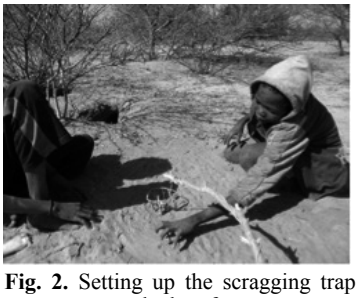

Fig. 2. Setting up the scragging trap to catch dwarf mongoose

3-3-L. *Children's Bow and Arrow*

Mothers give toy bows and arrows to their sons to play with when they are two or three years old. Once they turn four or five, they begin making their own bows and arrows for shooting birds and lizards with the older boys. When they are successful, they cook the game (using steam by burying their meat near a bonfire) on their own and eat it. Boys will hunt with their toy bows and arrows until they reach 12 or 13.

3-3-M. *Slingshot*

Boys make a slingshot from a tree branch and rubber cut from a tire tube to shoot small birds, lizards, and mongoose.

3-3-N. *Luring Game such as Birds by Sprinkling Bait*

This hunting method is also used by boys. A pot lid or something like it is propped against a stick, and bait, such as cornmeal, is sprinkled underneath. The boys then wait for a small bird to come down, when they catch it by dashing and knocking down the lid.

3-3-O. *Ambushing Birds that Gather Around a Watering Puddle*

Another hunting method used by boys is that in which two stakes are driven into a puddle and a piece of rubber (tire tube), about 15 cm in length, is tied to each stake. The ends of the wire are tied to the rubber, a strip of cloth is wrapped around the center of the wire, and both the cloth and the wire are drawn back to the full extent, while the boys wait in a prone position. Then, when the birds flock together to drink, the boys pull the cloth hard to release the wire, so that it flies over the water from the force of the rubber to shoot the birds.

4. THE PROCESS BY WHICH BOYS DEVELOP HUNTING SKILLS AND GAIN KNOWLEDGE ABOUT ANIMALS

Of the games played by boys, those that seem to help them acquire the knowledge and skills required for hunting include making handicrafts, shooting toy bows and arrows, trapping, and using slingshots. Through these activities, boys learn about small animals, such as lizards, birds, and mongoose, and develop skills such as learning how to set up a trap.

Boys begin using a knife at around the age of five, receiving their own knife when they are about ten (Akiyama, 2004). In addition to activities that involve shaving wood or potatoes, making toys, and playing games, such as spinning tops and stick flicking (i.e., throwing tree branches down on the ground to flick them forward), due to the influence of formal schooling in recent years, they also make model cars and airplanes, as well as their own bows and arrows, slingshots, and ropes for trapping. This is how boys learn to use a knife, tie strings, and learn about the characteristics of different materials, such as plant, metal, rubber, and plastic.

Whereas girls primarily spend time with the adult women, including their moth-

ers, help care for small children, and gather plants, boys often form their own groups and play away from the adults. Although these groups consist of boys aged between five and 12, only the boys aged eight or older go deep into the bush, when necessary, to play at trapping for example.

When an older boy is making something using a knife, the younger boys will sit around him and watch his handwork closely. Indeed, it is rare for adults to teach boys; in most cases, boys master skills through observing their older playmates, copying them, trying out what they have seen for themselves, and then observing the older boys again; that is observational learning. Also they learn the skill through trial and error by themselves. So their learning process might be a combination of observational learning and trial and error. For example, in the case of four boys—a nine-year-old and three 12-year-olds—who were playing at trapping to catch a bird, the nine-year-old was the only one who struggled to set up a trap. Perhaps unable to stand by and watch any longer, his older brother, one of the 12-year-olds, set up the trap for him, while the nine-year-old watched his brother's work intently, though no words were exchanged. Thus the process of acquiring hunting skills, especially during childhood, involves having younger boys observing and mimicking the older boys in their group of playmates, rather than receiving verbal instruction.

In addition, once they reach about ten years of age, boys will occasionally participate in horseback hunting with the youths and adults. Those who have learned how to handle a donkey might go as porters, and observe the experienced hunters. By accompanying other youths a few times, boys also learn how to hunt springhare using a pike pole; by the time they are about 12 years old, they begin hunting on their own with dogs.

Boys also observe the behavior and work of their elders carefully, and learn while accompanying adults on hunting trips; however, knowledge is often communicated verbally in these situations. One such example is that of the San's ethnic wisdom regarding animals: Fictitious sibling relationships between animals (it is worth noting that "sibling" is defined here in the San sense: a broad same-generation kinship, including parallel cousins, with distinctions between young and old). This grouping is based on the assumption that there are sibling relationships between animals of similar appearance and habits; a belief which can be regarded as a type of folk taxonomy or phylogeny.

A typical example is that the San perceive that there is a sibling relationship among large antelopes—the main game for the San people—Cape eland, greater kudu, gemsbok, and red hartebeest (in order from oldest to youngest). Likewise, the same applies to Felidae carnivores: lions, leopards, cheetahs, and African wildcats. This fictitious sibling relationship is sometimes assumed for birds and plants, indicating that the San people understand surrounding animal and plant species by relating them to one another.

In terms of the names of animal species, a survey in 2005, conducted by using an illustrated encyclopedia of animals, revealed that all boys aged around ten knew the names of most of the major animals; this was so despite the fact that the number of animals actually seen was about half that observed by youths aged about 20. The names of animals are learned in school, and by boys asking older

individuals to translate the Tswana and English names of animals never seen except in schoolbooks, into the San language.

On the other hand, the inferred sibling relationship between animals cannot be learned at school; this is knowledge handed down orally by adults to youths and boys, while hunting and actually coming face-to-face with the animals. When one of the authors (Akiyama) asked six boys, aged around ten, whether they knew of 11 fictitious sibling relationships, 11 out of 66 (about 17%) were at least partially known; this increased to 29 out of 77 (about 38%) among seven youths about 20 years of age. Youths as well as boys have relatively poor knowledge of these relationships, but this is because they have not had as much hunting experience as youths had in the past, because they were forced to relocate from the Central Kalahari Game Reserve to a planned village outside the reserve when they were about 12. This is of note because there is a group of individuals who frequently hunt with horses, among whom two 24-year-olds are quite familiar with the inferred sibling relationships, and have seen all of those animals. In other words, this traditional knowledge is inseparable from the practice of hunting: It is knowledge that can only be conveyed when a connection is made between a story told by the elders and the direct observation of those animals.

5. THE REALITIES OF HUNTING

When hunting, hunters must combine various hunting methods and show respect for the animals they encounter. In addition, while in the bush, they must constantly reconsider their plans and their predictions concerning the behavior of the animals being hunted, based on their keen observations of the trees and grass that wild animals eat, any signs that the animals have eaten those plants, noting animal footprints, how the grass is bent, and fecal droppings.

For purposes of illustration, a day of hunting by San men, as described in a paper by Ikeya (1989), is summarized in the following paragraph.

1) Four men with dogs leave before 9 am to go spear hunting. 2) They hunt an adult steenbok with their spears and dogs, with success. 3) They try to hunt a springhare, without success. 4) They identify a pride of lions and change the course they planned to take. 5) They find a bird's nest and gather eggs. 6) Suspecting that the parent birds must be nearby, they set up a trap quickly and catch one. 7) They find an African wildcat, and catch it using dogs and clubs. 8) They also catch a steenbok calf with clubs. 9) They find a cape hare, but decide not to hunt it. 10) They find a steenbok calf, but again decide not to hunt it. 11) They return to camp in the early afternoon because it looks like it is going to rain.

Thus, the four men caught one adult steenbok, one steenbok calf, one African wildcat, one bird (probably a type of bustard), and several eggs—all in about four hours in the morning.

Takada (2008) pointed out the rich ecological knowledge among the Central Kalahari San. He described how to get the information of animal behavior as follows: By examining spoor and casts of animals, hunters can determine an incredible amount of information, including the species, sex, number, and size of

the animals in question. They are not only able to accurately establish the animals' movements and direction by tracking their spoor, but can also estimate the approximate time that has elapsed since the animals left these traces, aiding greatly in their pursuit and eventual capture.

6. DISCUSSION

6-1. Hunting Methods of the San People

This interview survey on hunting methods clarified the following:

(1) It confirmed that hunting is a complex endeavor. While the San mainly catch small-sized mammals, such as steenbok and bush duiker, by trapping, as in the past, they also use traps intended to catch large mammals, such as red hartebeest, gemsbok, greater kudu, and blue wildebeest. Furthermore, we confirmed that there were traps for large and medium-sized birds, such as ostrich, kori bustard, red-crested korhaan, and black korhaan. In order to set these traps effectively, the San people had to read animal behavior very astutely.

(2) In addition to using traps, the San catch animals, such as aardvark and springhare, in burrows, by identifying footprints, signs of feeding, traces left in the sand, and the condition of the grass. They also hunt warthog by driving them into holes.

(3) Women also trap and hunt with dogs, and either set up a trap while gathering the day's food, or while hunting with a dog. The fact that the rope used for trapping is made primarily by women shows that women play very important role with this hunting method.

(4) We found that boys set up traps for small and medium-sized birds and small mammals, such as mongoose, as part of their play activities. This type of play-hunting is still taking place today, and boys are learning how to read nature through these experiences.

As mentioned above, it became clear that the hunting methods of the San people are wide-ranging, and it is not only adult men but also boys and adult women who hunt. In general hunter-gatherers' children are active forager gathering plant food and/or small game animals and birds, and they are capable of collecting a considerable amount of food (Blurton-Jones et al., 1994; Crittenden et al., 2013; Hagino & Yamauchi, 2014). Boys begin learning how to read nature from the older boys at around the age of four or five.

On the other hand, women might begin practical hunting activity only after they got married; however, they seem to have learned about the hunting methods while they were young and single, through activities such as food-gathering, and observing adult women hunting in the bush.

The ability to make observations that allow hunters to choose the right location for hunting and tracking game is just as important as having the physical capabilities for killing it. Likewise, understanding animal behavior well enough to be able to find the game, and then track wounded game, determines a hunter's success in bow and spear hunting. In addition, because a varied sequence of

events can occur in the bush, even when gathering food, the San must be able to respond to unexpected situations in nature. For the San, walking around the bush reading and interacting with nature is the most important activity of any day; both men and women then hunt and gather food based on the time and situation.

6-2. THE LEARNING PROCESS IN HOW TO READ NATURE

San boys observe older boys carefully from an early age, and acquire various skills and knowledge by imitating them. In this process, there is no verbal guidance; trial and error by repeated observation and practice plays a central role in their informal education.

Boys learn the characteristics and appropriate use of each material and plant while using a knife to play with plants and making toys such as bows and arrows. A lizard, which is a prey when playing with a bow and arrow, becomes bait to catch a mongoose when playing at trapping, while bait for catching a bird includes wild watermelon and termites' nests found in the ground. This knowledge is passed down by adults, such as parents; however, boys learn the actual practical methods while playing with the older boys. We are capable of learning things that require complex procedures and concepts, such as relationships, because humans can communicate information using language. However, this study suggests that it is necessary to directly observe and imitate the behavior of our elders in order to have a proper relationship with nature, including both animals and plants, in a given situation. Meanwhile, communicating information through the use of language is also important. Without language, it is impossible to create a mental image of animals and share that image with others. When parents teach their young children about animals, it is mainly about harmful creatures called *paaxo* (ones that bite), such as snakes and scorpions; however, stories told to children around a bonfire also play an important role. For example, Tanaka (2014) pointed out that animals and humans are inseparable because most of the characters that appear in San stories are animals that are always personified, while maintaining their animal characteristics.

The inferred sibling relationships between animals described in this paper are products of the imagination, attempts to understand animals by using the metaphor of human kinship, or a type of personification. This knowledge can only be passed down through language, but it is reinforced during regular hunting practices, by actually seeing the animals, and making observations.

We must be cautious about assuming that there is validity in discussing early AMH solely on the basis of the San people. However, it is probably correct to think that, as hunter–gatherers, early AMH must have used their imaginations—which are probably reflected in their murals and other drawings—in relation to animals. Sugawara (2012) asserts that two groups of San in different eras and regions, with different languages, share the same attitudes toward animals, stating that: "The hunter–gatherer people in southern Africa must have lived through some common intercorporeality." Regardless of whether they were living in south-

ern Africa or not, it seems that people who survive by hunting animals have many similarities in how they acquire the knowledge and skills for hunting, and the way in which they use their imaginations in relation to animals, namely, acquiring hunting skills through observation, imitation, trial and error, and the act of intercorporeality that attempts to personify animals and read their intentions.

6-3. The Human–Animal Relationship throughout Human History

Comparing the ability of Homo sapiens (AMH) with that of Neanderthals, it seems that the unique tendency of humans to take an interest in and observe animals in order to read their minds is closely related to human evolution (Shipman, 2011). During the Ice Age, Homo sapiens left numerous rock paintings, as well as images and patterns etched on hunting equipment. In contrast, the Neanderthals left nothing that indicates they perceived a relationship between humans and animals, other than prey–predator behaviors, even though we know they were dependent on large animal hunting to an even greater extent than modern hunter–gatherers in the Arctic (Snodgrass & Leonard, 2009).

It cannot be concluded that Homo sapiens in the Ice Age were the same as modern hunter–gatherers psychologically; however, hunter–gatherers such as the San people do keep the lines of communication with nature open through a word *!nare* meaning as "signs" and "senses" (Sugawara, 2001; Imamura, 2010). This could be the result of learning in a dream that an animal is caught in a trap, or recognizing from experience that when their armpits are feeling hot they are nearing the game, for instance. In the stories they tell, animals often speak human languages, and sometimes inform humans about what will happen in the area. In such a relationship, animals are no longer merely a source of human food, they are creatures with whom hunters have learned to share nature and communicate.

Some ethnic groups describe such a human–animal relationship as: "We can talk with animals" (Yamaguchi, 2012); a close relationship that includes varying degrees of "real" communication has been reported in studies of hunter–gatherers throughout the world (Ingold, 1989; Terashima, 2001; Nadasdy, 2007; Okuno et al., 2012). This relationship between humans and animals has probably evolved with humans' fundamental cognitive capabilities. The personification process involved in treating animals and nature as human also prompts changes in how humans view themselves. Human cognition, as it relates to San hunting methods and techniques, involves an understanding of imitation, psychological theories, and the practice of personification.

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